Optimization of a Single Emulsion Method for the Encapsulation of an Anti-Cancer Drug in Nanoparticles

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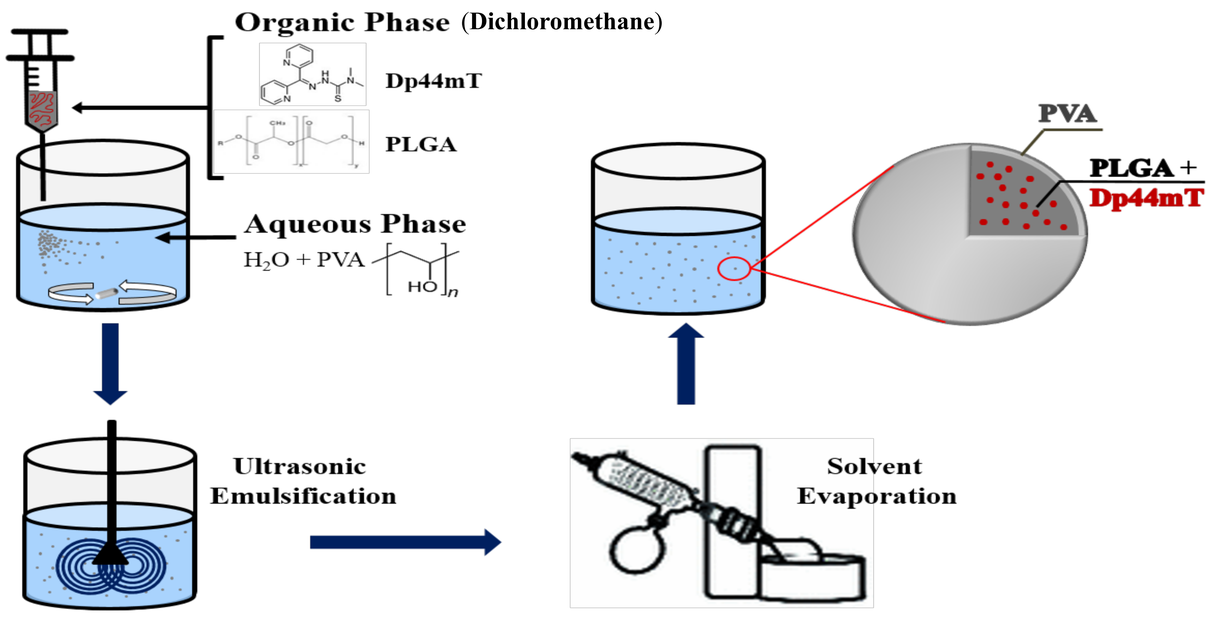
Background

- **Nanomedicine:**
  - Nanoparticles are viable carriers of therapeutic drugs used to treat cancers
  - Opposed to nanoprecipitation, nanoparticles fabricated via single emulsion are formed as the water immiscible solvent evaporates
- **Di-2-pyridylketone-4,4dimethyl-3-thiosemicarbazone (Dp44mT):**
  - Anti-tumor drug, Dp44mT, is a part of the thiosemicarbazone family of drugs that readily chelate free iron required by proliferating cells
  - This drug is a hydrophobic compound (285.37 Da)
- **Goal:** Optimize a single emulsion protocol used to encapsulate the anti-tumor drug, Dp44mT, within a nanocarrier used for drug delivery.
- **Parameters Optimized:**
  - Injection rate
  - Emulsifier concentration
  - Polymer concentration

In this study, we compare the optimization of a single emulsion protocol to an established nanoprecipitation method.

Methodology

Fabrication via Single Emulsion

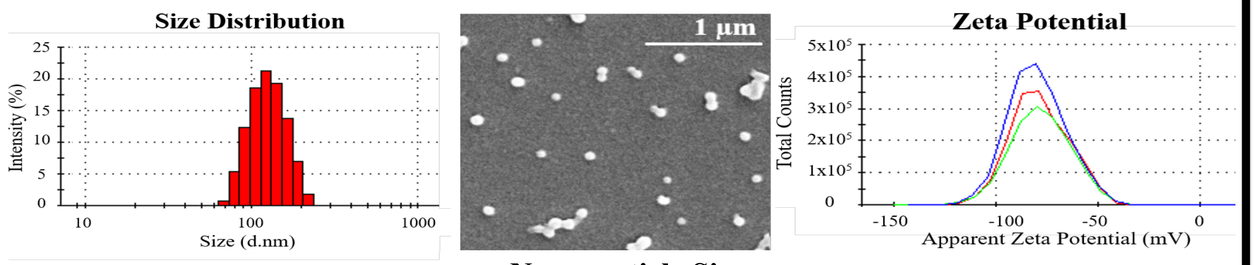


Encapsulation Efficiency & Loading Capacity

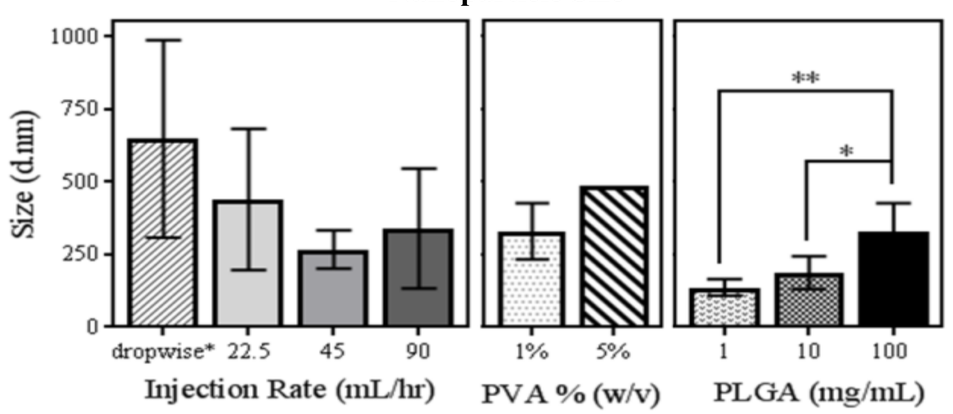
$$EE\% = \frac{\text{mass of encapsulated drug}}{\text{mass of drug in organic phase}} \times 100 \qquad LC\% = \frac{\text{mass of encapsulated drug}}{\text{total mass of nanoparticles}} \times 100$$

Results

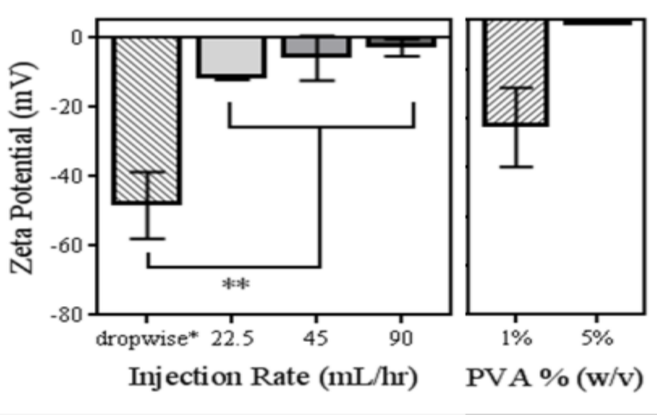
Characterization
Size, Morphology, & Surface Potential



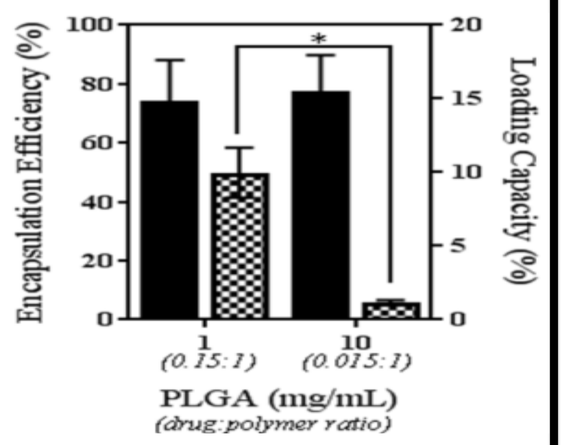
Nanoparticle Size



Zeta Potential



Encapsulation Efficiency & Loading Capacity



Comparison (Nanoprecipitation vs Single Emulsion)

- **Nanoprecipitation**: average size of 117 nm, surface zeta potential of -4.1 mV
  - Highest measured encapsulation efficiency of ~89% and a loading capacity of ~3.2%.
- **Single emulsion:** average size of 136 nm, surface zeta potential of -1.2 mV
  - Highest measured encapsulation efficiency of 77% with a lowest loading capacity of 1.15%

Conclusions

- **Optimal formulation:** 1mg/ml PLGA, 1% PVA, 90 ml/hr injection rate
- **Resulting particles attained:**
  - Desired particle size of ~136 nm.
  - Negative zeta potential, indicating good colloidal stability
  - Optimal loading capacity (~9.5%) and encapsulation efficiency (~74%)
- **Overall:** Both nanoprecipitation and single emulsion prove to be viable techniques in producing nanocarriers for Dp44mT

References

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